ESL-TR-16-03-01

QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR COMPUTATION OF CREDITABLE STATEWIDE EMISSIONS REDUCTIONS

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ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

TEXAS A&M ENGINEERING
EXPERIMENT STATION
Energy Systems Laboratory

May 10, 2016

Vincent Meiller
Air Quality Planning Section, Air Quality Division
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, TX 78711-3087

Dear Mr. Meiller:

The Energy Systems Laboratory (Laboratory) at the Texas A&M Engineering Experiment Station of the Texas A&M University System is pleased to provide Quality Assurance Project Plan (QAPP), "Computation of Creditable Statewide Emissions Reductions" obtained through wind and other renewable energy resources for the State Implementation Plan (SIP), as required under Texas Health and Safety Code § 386.252 (a)(14).

Please contact me at (979) 845-1280 should you or any of the TCEQ staff have any questions concerning this report or any of the work presently being done to quantify emissions reduction from energy efficiency and renewable energy measures as a result of the TERP implementation.

Sincerely,

David E. Claridge, Ph.D., P.E.
Director

Disclaimer

This QAPP is provided by the Texas A&M Engineering Experiment Station (TEES) as required under Section 386.252(a)(14) of the Texas Health and Safety Code and is distributed for purposes of public information. The information provided in this QAPP is intended to be the best available information at the time of publication. TEES makes no claim or warranty, express or implied, that the report or data herein is necessarily error-free. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring by the Energy Systems Laboratory or any of its employees. The views and opinions of authors expressed herein do not necessarily state or reflect those of the Texas A&M Engineering Experiment Station or the Energy Systems Laboratory.

ACKNOWLEDGEMENTS

This work has been completed as a fulfillment of the requirements in Texas Health Code, Section 386.252(a) (14), which requires the Laboratory to assist TCEQ in quantifying emissions reductions credits from wind and other renewable energy programs, through a contract with the Texas Environmental Research Consortium (TERC).

The authors are also grateful for the timely input provided by the following individuals, and agencies: Mr. Art Diem, US EPA, for providing the eGRID database and Vincent Meiller and Robert Gifford, TCEQ.

CONTENTS

1 PROJECT DESCRIPTION AND OBJECTIVES

The Energy Systems Laboratory (ESL) has prepared this Quality Assurance Project Plan (QAPP) following EPA guidelines. The nature of the technical analysis and tasks to be conducted as part of this project are consistent with Quality Assurance (QA) *Category III: Data Evaluation or Use for Secondary Purpose for projects* involving applied research or technology evaluations as outlined in EPA's NRMRL QAPP: Requirements for Secondary Data Projects.[1]

1.1 Purpose of Report

In the field of Renewable Energy (RE) that requires complex modeling of physical systems, a recognized method for improving model performance and realism is to run the model frequently and to compare its results with real observations. This method is used in the field of RE evaluations, and has resulted in great progress in measuring the savings from RE programs. The ESL has developed methods for calculating energy savings and NOx reductions from the renewable energy programs from multiple Texas state agencies working under Senate Bill-5 and Senate Bill-7.

The purpose of this project is to calculate integrated NOx emission reductions from multiple state agencies participating in the Texas Emission Reduction Plan (TERP), and allowing TCEQ to consider the combined NOx savings for Texas' State Implementation Plan (SIP) planning purposes.

1.2 Project Objectives

The ESL has and will continue to provide leading-edge technical assistance to counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering NOx emissions and improving the air quality for all Texans. The ESL will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US Environmental Protection Agency (US EPA). The efforts taken by the ESL have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP.

[1] http://www.tceq.state.tx.us/airquality/airmod/project/quality-assurance

2 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Responsibilities of Project Participants

This study has been conducted by the Energy Systems Laboratory under contract to the Texas Commission on Environmental Quality (TCEQ).
Dr. Haberl is the principal investigator of the study, who provides technical consultation, reviews quality assurance and analyzes the final results. Mr. Bahman Yazdani is the co-principal investigator of this study. Dr. Baltazar is the project manager, who oversights the technical system design, prepares final report and develops anthropogenic emissions data from EPA and WRF meteorological data. Mr. Patrick Parker is the computer system administrator and provides web page development and maintenance services, daily monitoring of the system operation and data archival and backup.
The ESL team working on this project and their specific responsibilities are listed below.

Table 1. The ESL project team participants and their responsibilities.

Participant	Project Responsibility
Jeff Haberl Bahman Yazdani	• Principal Investigator, technical consultant, quality assurance review • Co-Principal Investigator
Juan-Carlos Baltazar	• Project Manager with technical oversight of the system design, implementation and application • Preparation of final project report • Developing anthropogenic emissions using data from EPA
Patrick Parker	• Computer systems administrator for the computers dedicated to hosting the system • Data archival and backup • Web page development and maintenance
Patrick Parker Juan-Carlos Baltazar Jeff Haberl	• Daily monitoring of system operation • WRF meteorological DATA and analysis of results • Analysis of results

2.2 Project Schedule

The project is divided into eight major tasks. In Task 1 a work plan developed and submitted to TCEQ for review and approval. In Task 2 a QAPP is developed and submitted to TCEQ foe review and approval. In Task 3 a method for calculating statewide NOx emission reduction is developed. And in Task 4 the modeling system developed in Task 3 is deployed. In Task 5 and Task 6 the modeling system is evaluated and enhanced as needed. In Task 7 a draft report is prepared that details the results of the project and work methods. In Task 8 the draft report is submitted to TCEQ for review and approval. Table 2 shows the overall schedule for completion of this project including interim milestones.

Table 2. Summary of project schedule and milestones.

Work Element	Completion Date
Task 1 Work plan submitted to the TCEQ for review and approval	**Completed**
Task 2 QAPP submitted to the TCEQ for review and approval	**March 2016**
Task 3 Develop and compute creditable statewide NOx emission reduction	**Mar-Jul 2016**
Task 4 Deploy Modeling System	**Mar-Jul 2016**
Task 5 Evaluate Modeling System	**Mar-Jul 2016**
Task 6 Enhance Modeling System	**Mar-Jul 2016**
Task 7 Prepare a report detailing the results of the project and work methods	**Mar-Jul 2016**
Task 8.1 Draft Final Report acceptable to the TCEQ	**07/15/2016**
Task 8.2 Final Report acceptable to the TCEQ	**08/15/2016**

3 SCIENTIFIC APPROACH

The electricity savings from RE programs will be calculated based on the 2008 baseline year. In addition, the NOx emissions calculations will use the 2010 eGRID database, which uses four Congestion Management (CM) zones: Houston, North, West, and South. This report calculates the Ozone Season Day (OSD) emission reduction by dividing the annual emission reductions by 365 days since the 2010 eGRID estimates the annual emissions only.

The OSD emissions reductions from the electricity generated by wind farms were estimated using measured annual data provided by ERCOT. Data used in each reporting cycle was obtained from the previous year data sources. For example, 2014 data was used to prepare the 2015 report.

3.1 Data Needed to Meet Project Objectives

Several types of data are required to accomplish the project objectives. These are:

- Meteorological input data;
- Annual electricity savings;
- Annual electricity consumption;
- Annual electricity production;
- Single and multi-family program energy savings; and
- Renewable energy projects input data**.**

3.2 Data Sources

Below are the data sources of each data type used for calculation and analysis in the report. The reference for each data sources are given as well as a brief summary of each source.

Table 3: Data Types and Sources

Source / Data Type	PUC	SECO	ERCOT	HIRL[2]	TCEQ	EPA	NREL	NCEI[3]
Meteorological Input Data	☐	☐	☐	☐	☑	☐	☑	☑
Annual Electricity Savings	☑	☑	☐	☐	☐	☐	☐	☐
Annual Electricity Consumption	☑	☑	☐	☐	☐	☐	☐	☐
Annual RE Electricity Production	☐	☐	☑	☐	☐	☐	☐	☐
Single & Multi-Family Program	☐	☐	☐	☑	☐	☐	☐	☐
Other Renewable Energy Projects	☐	☐	☐	☑	☐	☑	☑	☑

[2] In 2013, the NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: https://www.homeinnovation.com

[3] National Center for Environmental Information

3.2.1 Meteorological Input Data

In order for the ESL to develop this report for TCEQ, Meteorological data was obtained from the National Renewable Energy Laboratory (NREL) and the National Center for Environmental Information (NCEI), and Solar radiation data from TCEQ website.

Datasets from NREL are received through the following contact:

Contact Information: http://rredc.nrel.gov/solar/old_data/nsrdb/

Datasets from NCEI are received through the following contact:

Contact Information: http://ncdc.noaa.gov

Datasets from PUCT are received through the following contact:

Name: Ms. Therese Harris

Contact Information: Therese.Harris@puc.texas.gov

Datasets from SECO are received through the following contact:

Name: Mr. Dub Taylor

Contact Information: Dub.Taylor@cpa.texas.gov

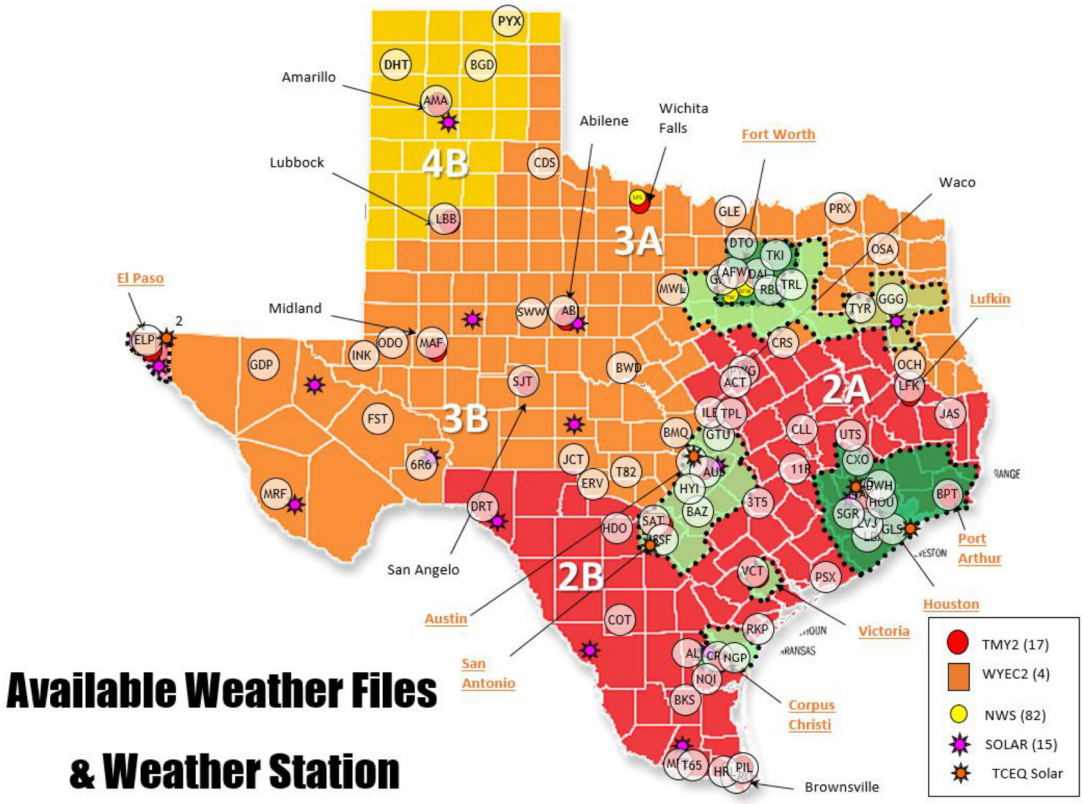
Datasets for wind and renewable sources through the following contact:

Name: Mr. Paul Wattles

Contact Information: Paul.Wattles@ercot.com

Shown in Figure 1 are the locations of the various weather data sources that have been used, including the Typical Meteorological Year (TMY2) (NREL 1995[4]) stations, the Weather Year for Energy Calculations (WYEC2) (Stoffel 1995) weather stations, the National Weather Service weather stations, (NWS) (NOAA[5]) weather stations, the ASHRAE 90.1 2013 weather locations[6], the solar station data provided by the National

[4] National Renewable Energy Laboratory. See more at: https:// www.nrel.gov
[5] National Oceanic and Atmospheric Administration. See more at: https:// www.noaa.gov, formerly NOAA.
[6] The ASHRAE 90.1-2013 stations are used in the emissions calculator for determining the building characteristics. See more at: https://www.ashrae.org



List of Available Weather Files and Weather Stations of Texas

Texas Weather Stations (NOAA)

1	Abilene Regional Airport (ABI)
2	Alice International Airport (ALI)
3	Amarillo International Airport (AMA)
4	Angleton / Lake Jackson Brazori (LBX)
5	Arlington Municipal Airport (GKY)
6	Austin - Bergstrom International (AUS)
7	Austin Camp Mabry (ATT)
8	Borger Hutchinson County Airport (BGD)
9	BRENHAM: BRENHAM MUNICIPAL AIRPORT (11R)
10	Brownsville S Padre Is International (BRO)
11	BROWNWOOD: BROWNWOOD REGIONAL AIRPORT (BWD)
12	Burnet Municipal Airport (BMQ)
13	Childress Municipal Airport (CDS)
14	College Station (CLL)
15	Conroe Montgomery County Airport (CXO)
16	Corpus Christi International Airport (CRP)
17	CORPUS CHRISTI: CORPUS CHRISTI NAS/TRUAX FIELD ARPT (NGP)
18	Corsicana Campbell Field (CRS)
19	Cotulla La Salle Co Airport (COT)
20	Dalhart Municipal Airport (DHT)
21	Dallas - FortWorth International Airport (DFW)
22	Dallas Love Field (DAL)
23	Dallas Redbird Airport (RBD)
24	Del Rio International Airport (DRT)
25	Denton Municipal Airport (DTO)
26	Dryden Terrell County Airport (6R6)
27	El Paso International Airport (ELP)
28	FALFURRIAS: BROOKS COUNTY AIRPORT (BKS)
29	Fort Stockton Pecos County Airport (FST)
30	FortWorth Alliance Airport (AFW)
31	FortWorth Meacham (FTW)
32	FREDERICKSBURG: GILLESPIE COUNTY AIRPORT (T82)
33	GAINESVILLE: GAINESVILLE MUNICIPAL AIRPORT (GLE)
34	Galveston Scholes Field (GLS)
35	GEORGETOWN: GEORGETOWN MUNICIPAL AIRPORT (GTU)
36	Harlingen Rio Grande Valley I (HRL)
37	Hondo Municipal Airport (HDO)
38	Houston Bush Intercontinental (IAH)
39	Houston Clover Field (LVJ)
40	Houston Hooks Memorial Airport (DWH)
41	Houston Sugarland Mem (SGR)
42	Houston William P Hobby Airport (HOU)
43	Huntsville Municipal Airport (UTS)
44	JASPER: JASPER COUNTY-BELL FIELD AIRPORT (JAS)
45	Junction Kimble County Airport (JCT)
46	KERRVILLE: KERRVILLE MUNI/LOUIS SCHREINER FLD AIRPORT (ERV)
47	KILLEEN: KILLEEN MUNICIPAL AIRPORT (LE)
48	KINGSVILLE: KINGSVILLE NAS AIRPORT (NQI)
49	LA GRANGE: FAYETTE REGIONAL AIR CENTER AIRPORT (3T5)
50	Longview ETX Rgnl Airport (GGG)
51	Lubbock International Airport (LBB)
52	Lufkin Angelina Cty Airport (LFK)
53	MARFA: MARFA MUNICIPAL AIRPORT (MRF)
54	McAllen Miller International Airport (MFE)
55	McKinney Municipal Airport (TKI)
56	Midland International Airport (MAF)
57	Mineral Wells Airport (MWL)
58	MOUNT PLEASANT: MOUNT PLEASANT REGIONAL AIRPORT (OSA)
59	NACOGDOCHES: A L MANGHAM JR REGIONAL AIRPORT (OCH)
60	New Braunfels Municipal Airport (BAZ)
61	Odessa Schlemeyer Field (ODO)
62	Palacios Municipal Airport (PSX)
63	PARIS: COX FIELD AIRPORT (PRX)
64	PERRYTON: PERRYTON OCHILTREE COUNTY AIRPORT (PYX)
65	Pine Springs Guadalupe Mountains (GDP)
66	Port Arthur Se Tx Rgnl Airport (BPT)
67	Port Isabel Cameron County Airport (PIL)
68	Rockport Aransas Co Airport (RKP)
69	San Angelo Mathis Field (SJT)
70	San Antonio International Airport (SAT)
71	San Antonio Stinson Municipal Airport (SSF)
72	SAN MARCOS: SAN MARCOS MUNICIPAL AIRPORT (HYI)
73	SWEETWATER: AVENGER FIELD AIRPORT (SWW)
74	TEMPLE: DRAUGHON-MILLER CNTRL TEXAS REGIONAL ARPT (TPL)
75	Terrell Municipal Airport (TRL)
76	Tyler Pounds Field (TYR)
77	Victoria Regional Airport (VCT)
78	WACO: MC GREGOR EXECUTIVE AIRPORT (PWG)
79	Waco Regional Airport (ACT)
80	WESLACO: MID VALLEY AIRPORT (T65)
81	Wichita Falls Municipal Airport (SPS)
82	Wink Winkler Co Airport (INK)

Texas TMY2 Weather Files

1	Abilene
2	Amarillo
3	Austin
4	Brownsville
5	Corpus Christi
6	El Paso
7	FortWorth
8	Houston
9	Lubbock
10	Lufkin
11	Midland
12	PortArthur
13	San Angelo
14	San Antonio
15	Victoria
16	Waco
17	Wichita Falls

Texas WYEC2 Weather Files

1	El Paso
2	Brownsville
3	FortWorth
4	San Antonio

NREL Solar Stations

1	Abilene
2	Austin
3	Big Spring
4	Canyon
5	Clear Lake
6	Corpus Christi
7	Del Rio
8	Edinburg
9	El Paso
10	Laredo
11	Mekard
12	Overton
13	Pecos
14	Presidio
15	Sanderson

TCEQ Solar Stations

1	Bexar
2	Travis
3	El Paso (2)
4	Galveston
5	Harris (5)

FCHART and PV FCHART (New Weather File)

1	ABILENE
2	AMARILLO
3	AUSTIN
4	BROWNSVILLE
5	CORPUS CHRISTI
6	EL PASO
7	FORT WORTH
8	HOUSTON
9	LUBBOCK
10	LUFKIN
11	MIDLAND-ODESSA
12	PORT ARTHUR
13	SAN ANGELO
14	SAN ANTONIO
15	SHERMAN
16	VICTORIA
17	WACO
18	WICHITA FALLS

Figure 1: Available NWS, TMY2 and WYEC2 weather files compared to IECC/IRC weather zones for Texas

Renewable Energy Laboratory (NREL)[7], the solar stations measured by the TCEQ[8], and F-CHART and PV F-CHART weather locations[9].

3.2.2 Annual Electricity Savings

The annual electricity savings for 2001 through 2014 are obtained from the Public Utility Commission of Texas.

3.2.3 Annual Electricity Consumption

The annual electricity consumption reported by political subdivisions for 47 counties through 2014 were obtained from the State Energy Conservation Office (SECO).

3.2.4 Annual RE Electricity Production

The measured electricity production from all the wind farms in Texas for 2001 through 2014 was obtained from the Electric Reliability Council of Texas (ERCOT).

3.2.5 Single and Multi-family Program Energy Savings

The ESL's single-family and multi-family programs include the energy savings attained by constructing new residences in Texas that meet the Texas Building Energy Performance Standard (TBEPs). The baseline to estimate energy savings uses the published data on residential construction characteristics from the 2014 National Association of Home Builders (NAHB 2014)[10].

3.2.6 Renewable Energy Projects Input Data

This report includes the electricity savings from renewable energy projects. The information is collected using the following methods:

- Information from the internet websites of manufacturers, distributors, and consultants related with renewable energy products.

- Information is collected by personally emailing individuals, who were either manufacturers, distributors or consultants.

- Information published from environmental agencies like the Electric Reliability Council of Texas (ERCOT), the Environmental Protection Agency (EPA),

[7] The NREL stations were the primary source of the global horizontal, direct normal and diffuse solar radiation used to determine the peak-day and annual emissions for the DOE-2 simulations for code-compliant housing and commercial buildings. https://www.nrel.gov

[8] The TCEQ stations were used as the secondary source for global horizontal solar radiation when the NREL sites were missing data or no NREL site was nearby.

[9] The F-Chart and PV F-Chart weather locations are used to determine the solar thermal or electricity produced by the systems specified by the use in the emissions calculation.

[10] For the 2014 report, the 2014 HIRL data (previously, NAHB data) were used. In 2013, the NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: http://www.homeinnovation.com

National Renewable Energy Laboratory (NREL), which is available to the general public.

Most of the present report data for solar photovoltaic projects were collected from the Open PV project database of National Renewable Energy Laboratory (NREL) (https://openpv.nrel.gov/). The solar thermal projects and geothermal projects throughout in the State of Texas were identified from other sources. The present report data for three renewable resources (i.e., solar power, biomass, and hydroelectricity) were obtained from the Electric Reliability Council of Texas (ERCOT). The hourly electricity generation data for the renewable resources were collected for year 2014. The information for the landfill gas-fired power plant section was provided by the Environmental Protection Agency's (EPA's) project database for Landfill Methane Outreach Program (LMOP) (https://www3.epa.gov/lmop/).

3.3 Adjustment Factors

Annual and Ozone Season Day (OSD) NOx emissions reductions were calculated for 2014 and integrated from 2009 to 2020 using several adjustment factors to discount the potential savings. These factors include an annual degradation factor, a transmission and distribution factor, a discount factor, and growth factors as shown in Table 4 and are described as follows:

Annual Degradation Factor: This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from wind, an annual degradation factor of 2% was used for ESL Single-family, Multi-family, and Commercial programs and an annual degradation factor of 5% was used for all other programs[11]. The value of the 5% degradation factor was taken from a study by Kats et al. (1996).

Transmission and Distribution Loss: This factor adjusts the reported savings to account for the loss in energy resulting from the transmission and distribution of the electricity from the electricity producers to the electricity consumers. For this calculation, the energy savings reported at the consumer level are increased by 7% to give credit for the actual power produced that is lost in the transmission and distribution system on its way to the customer. In the case of electricity generated by wind, the T&D losses were assumed to cancel-out since wind energy is displacing power produced by conventional power plants; therefore, there is no net increase or decrease in T&D losses.

Initial Discount Factor: This factor was used to discount the reported savings for any inaccuracies in the assumptions and methods employed in the calculation procedures. For the ESL's single, multi-family and commercial program, the discount factor was assumed to be 20%. For PUC's Senate Bill 7 program and electricity from wind, the discount

[11] For example a degradation of 5% per year would accumulate as a 5%, 10%, 15%...etc, degradation in performance. Although the assumption of this high level of degradation may not actually occur, it was chosen as a conservative estimate. For wind energy, a degradation factor of 0% was used. The choice of a 0% degradation factor for wind is based on two years of analysis of measured wind data from all Texas wind farms in Texas that showed no degradation, on average, for a two year period after the wind farms became operational.

factor was taken as 10%. For the savings in the SECO program, the discount factor was 60%. In addition, the discount factor for SEER 13 single-family and SEER 13 multi-family program was 20%.

Growth Factor: The growth factors shown in Table 1 were used to account for several different factors. Growth factors for single-family (3.3%), multi-family residential (1.5%), and commercial (3.3%) construction are projections based on the average growth rate for these housing types from recent U.S. Census data for Texas. Growth factor for wind energy (4.8%) is a linear projection based on the installed wind power capacity for 2009 through 2014 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13 entries. Table 4 shows the adjustment factors used in this report.

Table 4: Adjustment Factors for the Calculation of the Annual Savings

	ESL-Single Family	ESL-Multi Family	ESL-Commercial	PUC	SECO	Wind-ERCOT	SEER 13 Single Family	SEER 13 Multi Family
Annual Degradation Factor	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T & D Loss	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor	20.0%	20.0%	20.0%	10.0%	60.0%	10.0%	20.0%	20.0%
Growth Factor	3.3%	1.5%	3.3%	0.0%	0.0%	4.8%	N.A.	N.A.

4 QUALITY METRICS

The accuracy of the results depends on the accuracy of the input data, the aptness of the mathematical models, the precision of the computational techniques, and the overall program audit procedure.

The ESL used the best Meteorological, Annual electricity savings/consumption/production input data available, obtained from reliable State and National agency sources, which was discussed in Section 3 of this report. Also the ESL used acceptable and widely used software (e.g. DOE-2.1E) to simulate the energy use of buildings in Single and Multi-family programs. In this section, we specify the quality requirements for the data used in this report and describe the procedures for determining the quality of any secondary data.

The emissions reductions calculations for NOx will be independently reviewed by an appropriate party who did not conduct the original calculations or simulations so that 10% or more of the emissions reductions calculations data will be audited.

4.1 Single, and Multi-family Programs' Energy Savings

Figure 3 shows the overall information flow that was used to calculate the NOx emissions savings from the annual and OSD electricity savings (MWh) from all programs. For the ESL's single-family and multi-family code-implementation programs, the annual and OSD were calculated from DOE-2.1 E[12] hourly simulation models[13]. The base case is taken as the average characteristics of single- and multi-family residences for Texas published by the National Association of Home Builders for 2008 (NAHB 2008). The annual electricity savings from PUC's energy efficiency programs were calculated using PUC-approved demand savings calculations or tables or industry accepted measurement and verification methods (PUC 2015).

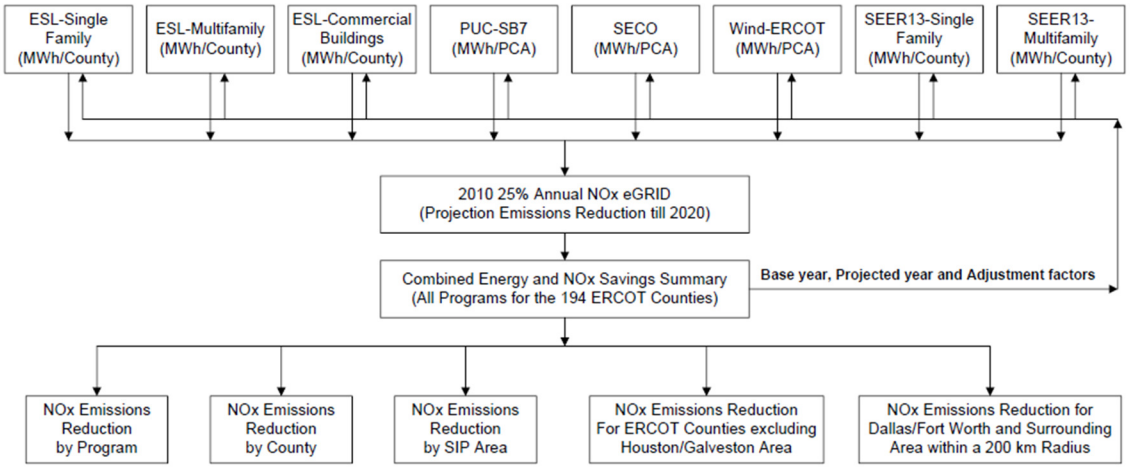


Figure 3: Process Flow Diagram of the NOx Emissions Reduction Calculations

[12] DOE-2.1 E is a widely used and accepted building energy analysis program that can predict the energy use and cost for all types of buildings, including compliance with ASHRAE standard 140.
[13] These values are based on a performance analysis as defined by Chapter 4 of IECC 2006. This analysis is discussed in the Laboratory's annual reports to the TCEQ.

4.2 Renewable Energy Project Input Data

Using the data collected by the procedure outlined in this report, the generated/saved energy from the renewable energy projects were calculated. To determine energy savings from solar photovoltaic and solar thermal, the eCalc[14] tool was used. Next, NOx emission reductions throughout the State of Texas were calculated based on the generated/saved energy. To determine NOx emission reductions, the 2010 eGRID was used. Figure 2 presents the work process to implement the analysis of other renewable resources, including the following steps: project classification, data collection, data preparation, NOx emission reductions calculation, and result production.

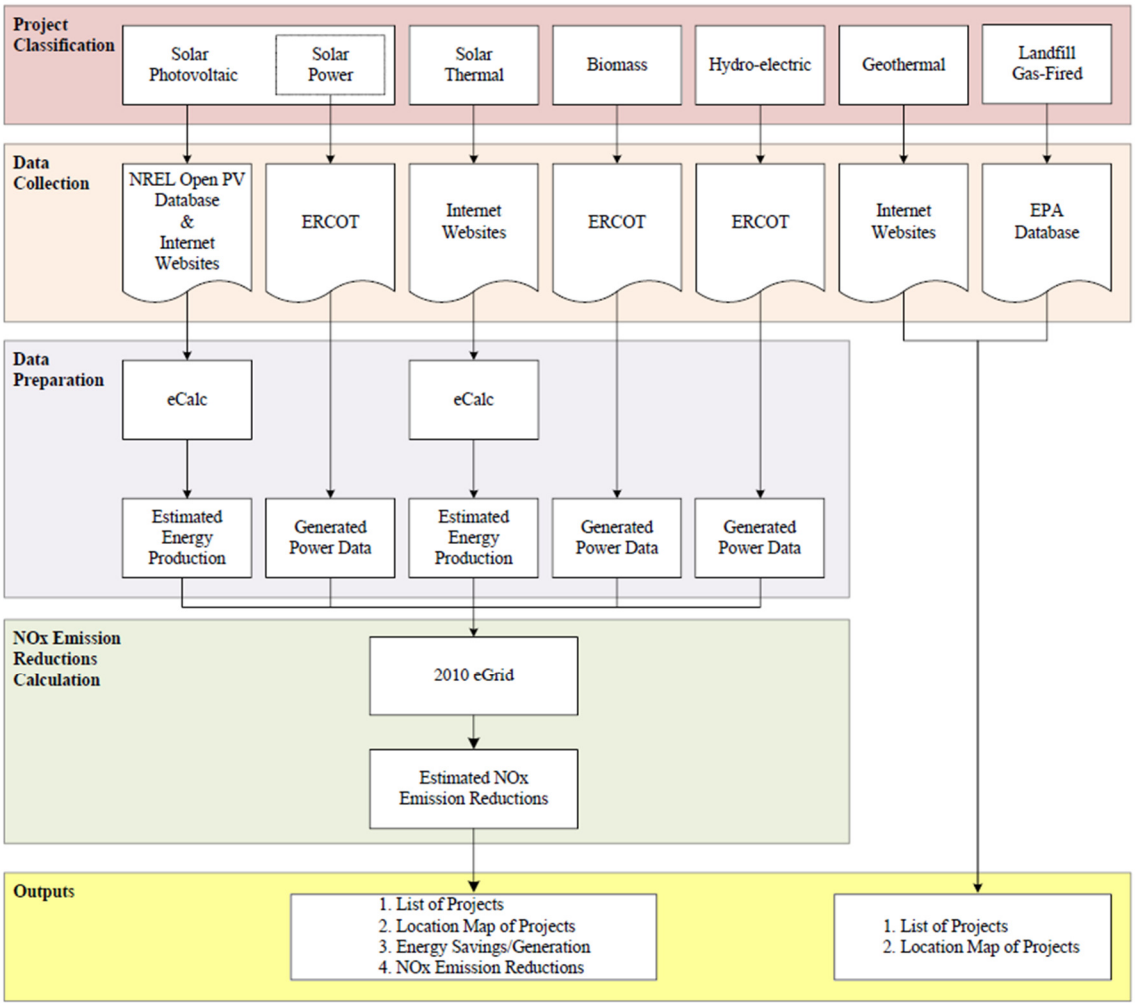


Figure 2: Chart of Work Flow for Other Renewable Energy Projects

[14] Now called IC3. The International Code Compliance Calculator (IC3) software is a web-based software tool for verifying and demonstrating that the annual performance of proposed new residences in Texas are in compliance with the Texas Building Energy Performance Standards (TBEPS).

5 DATA ANALYSIS, INTERPRETATION AND MANAGEMENT

5.1 Description of the Analysis Method/Calculation Procedure

5.1.1 ESL Single-family, Multi-family and Commercial Buildings

The calculation of the annual electricity savings reported for the years 2002 through 2014 included the savings from code-compliant new housing in all non-attainment and affected counties as reported in the ESL's annual report submitted by the Laboratory to the Texas Commission on Environmental Quality (TCEQ). From 2009 to 2014, based on year 2008, the annual electricity savings are calculated for new residential construction in all the counties in ERCOT region, which includes the non-attainment and affected counties. These savings are then tabulated by county and program. Using the calculated values through 2014, savings are then projected to 2020 by incorporating the different adjustment factors shown in Table 4.

In these calculations, it is assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2014 through 2020, minus degradation. The projected energy savings through 2020, according to county, are then divided into the CM zones in the 2010 eGRID. To determine which CM zone is to be used, or in counties with multiple CM zone, the allocation to each CM zone by county is obtained from CM zone's listing published in the Laboratory's 2010 annual report.

For the 2014 annual NOx emissions calculations, the US EPA's 2010 eGRID are used. The total electricity savings for each CM zone are used to calculate the NOx emissions reductions for each of the different counties using the emissions factors contained in eGRID. Similar calculations are performed for each year for which the analysis is required.

5.1.2 PUC-Senate Bill 7

For the PUC Senate Bill 7 program savings, the annual electricity savings for 2001 through 2014 are obtained from the Public Utility Commission of Texas. Using these values savings are projected through 2020 by incorporating the different adjustment factors which were previously mentioned. Savings are calculated for each year after 2014 until 2020. The 2010 annual eGRID is also used to calculate the NOx emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each CM zone are used to calculate the NOx emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet. The integrated NOx emissions reductions for each county are then calculated.

5.1.3 SECO Savings

The annual electricity consumption reported by political subdivisions for Texas counties through 2014 are obtained from the State Energy Conservation Office (SECO). Using the reported consumption, the annual and OSD electricity savings resulted from energy conservation projects are then calculated. To achieve this, the annual Energy Use Intensity (EUI) for each county is estimated and the county's energy savings for each

year against the baseline year of 2008 were then calculated. In addition, the savings through 2020 were projected using the different adjustment factors shown in Table 4. In a similar fashion to the previous programs, the electricity savings for each year through 2020 are calculated. The 2010 annual eGRID is also used to calculate the NOx emissions savings for the SECO program.

5.1.4 Electricity Generated by Wind Farms

The measured electricity production from all the wind farms in Texas for 2001 through 2014 was obtained from the Electric Reliability Council of Texas (ERCOT). To obtain the annual production, the 15-minute data are summed for the 12 months. Using the reported numbers for 2014, savings through 2020 are projected incorporating the different adjustment factors mentioned in Section 3. The 2010 annual eGRID is then used to calculate the NOx emissions reductions for the electricity generated by Texas' wind farms. The total electricity savings for each CM zone are used to calculate the NOx emissions reductions for each of the different counties.

5.1.5 SEER 13 Single-Family and Multi-Family

In January of 2006, Federal regulations mandated that the minimum efficiency for residential air conditioners be increased to SEER 13 from the previous SEER 10. Although the electricity savings from new construction reflected this change in values, the annual and OSD electricity savings from the replacement of the air conditioning units by air conditioners with an efficiency of SEER 13 in existing residences needed to be calculated. In this analysis, it is assumed that an equal number of existing houses had their air conditioners replaced, as reported for 2006, by the air conditioner manufacturers. This replacement rate continued until all the existing air conditioner stock is replaced with SEER 13 air conditioners.

In the 2014 report to the TCEQ, the annual and OSD electricity savings for all the counties in ERCOT region as well as the non-attainment and affected counties are calculated. Using the numbers for 2008, the savings after 2008 until 2020 are projected by incorporating the appropriate adjustment factors. The total electricity savings for each CM zone are used to calculate the NOx emissions reductions for each of the different county using the emissions factors contained in the 2010 eGRID. Integrated NOx emissions reductions for each county by SIP area are also calculated.

5.2 Data Storage Requirements

This project produces large amounts of model output data to be managed and archived. All project data reside primarily on a computer server that is dedicated to the TERP project. A copy of the software (i.e., computer models and scripts) that comprises the model is maintained on a separate computer hard drive for backup. Output data produced by the modeling system may be classified as primary and secondary data. The primary output data are the direct output files from the models which are large. The primary output data are used to prepare secondary output data and then moved to a separate hard drive for archiving. The secondary output data are maintained on a database server with a separate database that is dedicated to the TERP project.

There are several procedures that The ESL follows during and after completion of the project such as:

Backup/Recovery: Backup process follows standard Microsoft backup procedure. Backup is a daily activity that stores the database on the same physical server but on a different drive.

Network Access: Follows TEES firewall procedures and gives access to the database server only to persons who are involved in the project and need access.

Physical Access: The server room access is granted to only key individuals and management. Primarily, the Computer Operations staff and Network Support staff at the ESL and TEES have a legitimate need to be in the server room.

Disaster Recovery Planning: Restores database from the latest backup.

6 REPORTING

6.1 Project Deliverables Schedule

The schedule for all deliverables is presented in Section 2, Table 2.

6.2 Project Deliverable Report Details

Draft Reports will be delivered to the TCEQ Project Manager electronically (i.e., via file transfer protocol (FTP) or e-mail) in Microsoft Word format no later than the deliverable due date shown in Table 2.
Final Reports will be submitted by CD's of the full report and hard copy, 2 sets, just for the executive summary, to the TCEQ Project Manager no later than the deliverable due date shown in Table 2. The Reports detail the methods and results and include the following components:

1. An executive summary or abstract;
2. A brief introduction discussing the background and objectives, including relationships to other studies if applicable;
3. A discussion of the key findings, shortfalls, and remaining uncertainties;
4. Recommendations, if any, for what should be considered next as a new study; and

5. Appendices retaining the necessary data for the report.

The Final Report provides a comprehensive overview of activities undertaken and data collected and analyzed during the work. The Final Report highlights major activities and key findings, describe any problems encountered and associated corrective actions, as well as discuss important details regarding data and model uncertainties and limitations.

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